United States Patent [19]

Matsuda et al.

[11] **4,040,193**

[45] **Aug. 9, 1977**

[54] **DISPLAY DEVICE**

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June 10, 1975	Japan	50-78778[U]
July 11, 1975	Japan	50-97100[U]
Sept. 23, 1975	Japan	50-130345[U]

[51] **Int. Cl.**[2] **G09F 7/00**

[52] **U.S. Cl.** ..... **40/28 C**; 40/106.45

[58] **Field of Search** ..... 40/28 C, 133 R, 130 J, 40/130 C, 52, 106.45

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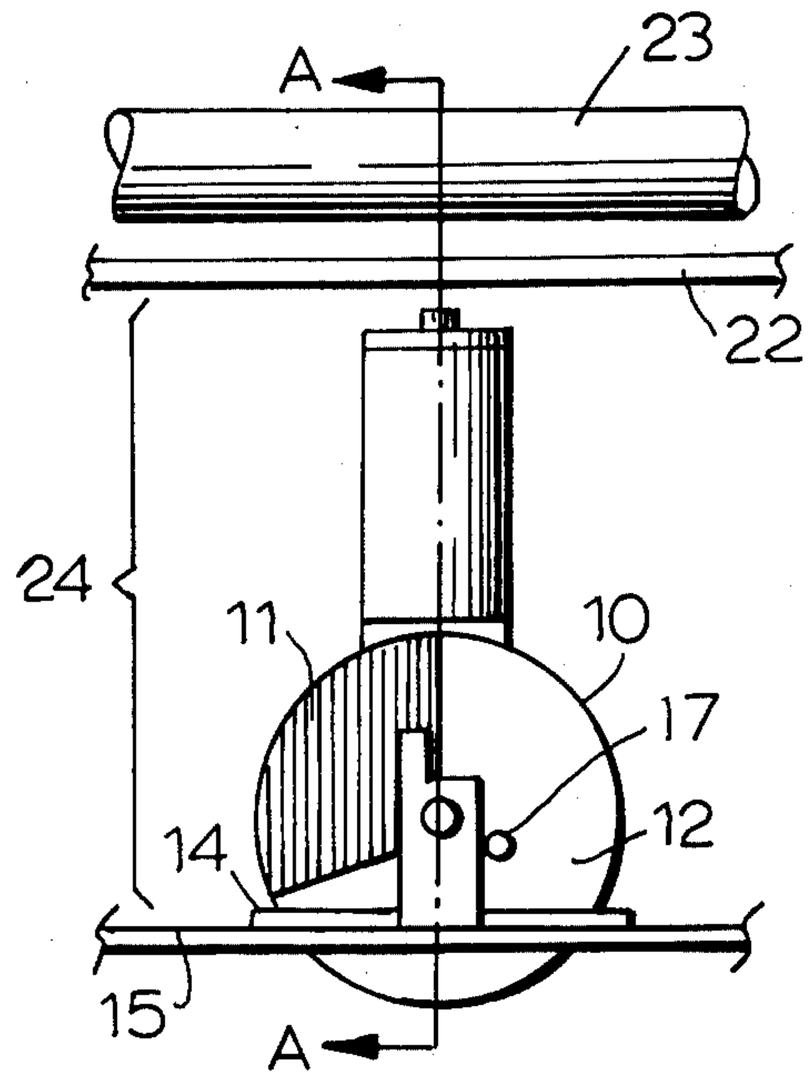
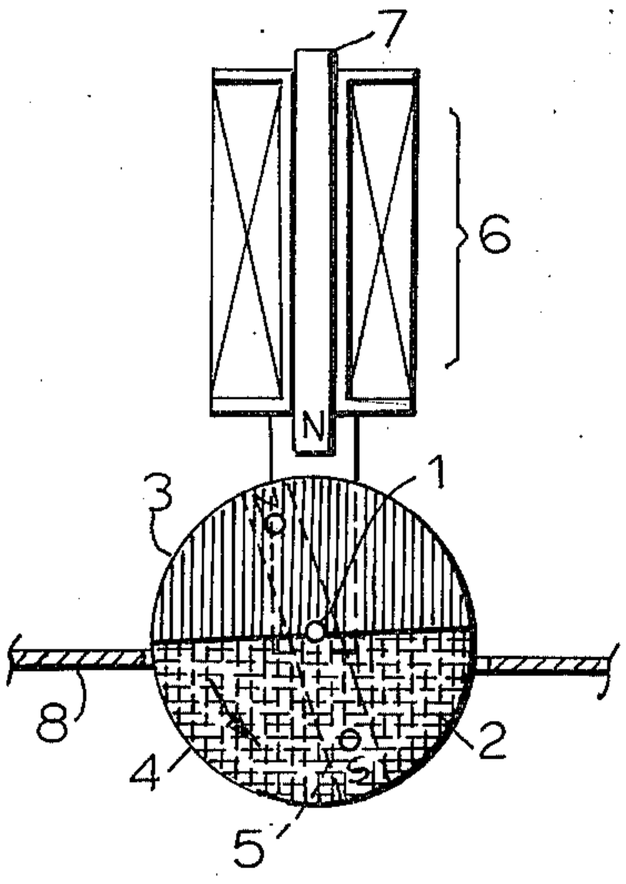
Primary Examiner—Russell R. Kinsey
Assistant Examiner—Wenceslao J. Contreras
Attorney, Agent, or Firm—Wenderoth, Lind & Ponack

[57] **ABSTRACT**

A display element is rotatably mounted and has a surface portion which includes a nontransparent area and a transparent area, and these two areas are different colors than each other. Such element is mounted behind a front panel having an opening facing the element. By controlling the rotational position of the display element, one of above described areas is selectively displayed. The transparent area can be positioned partly inside and partly outside the front panel, and light from a light source provided inside the front panel can be scattered through the display element.

5 Claims, 26 Drawing Figures





(PRIOR ART)

FIG.1

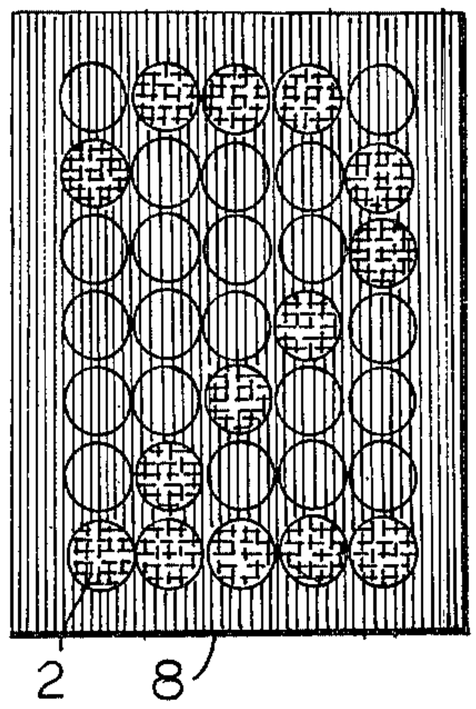


FIG.2

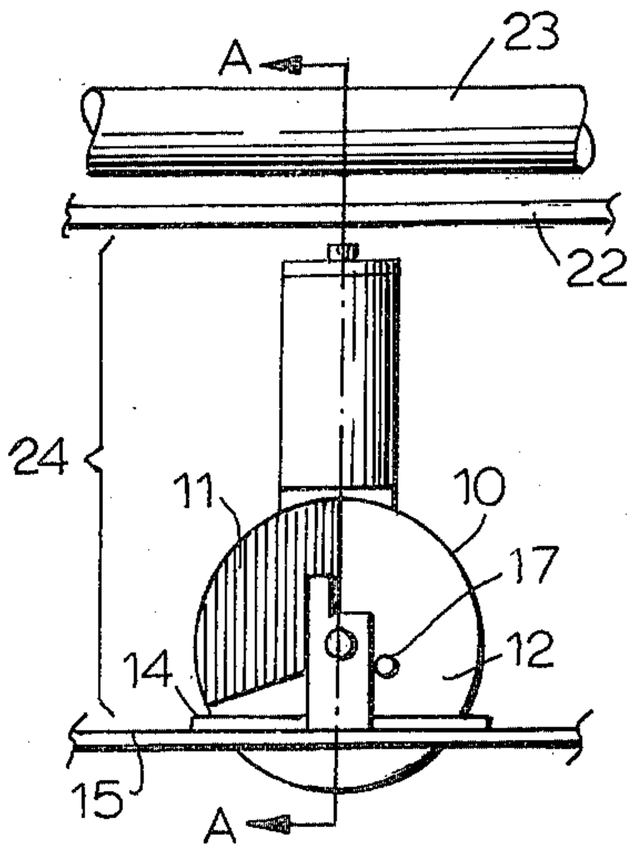


FIG.3

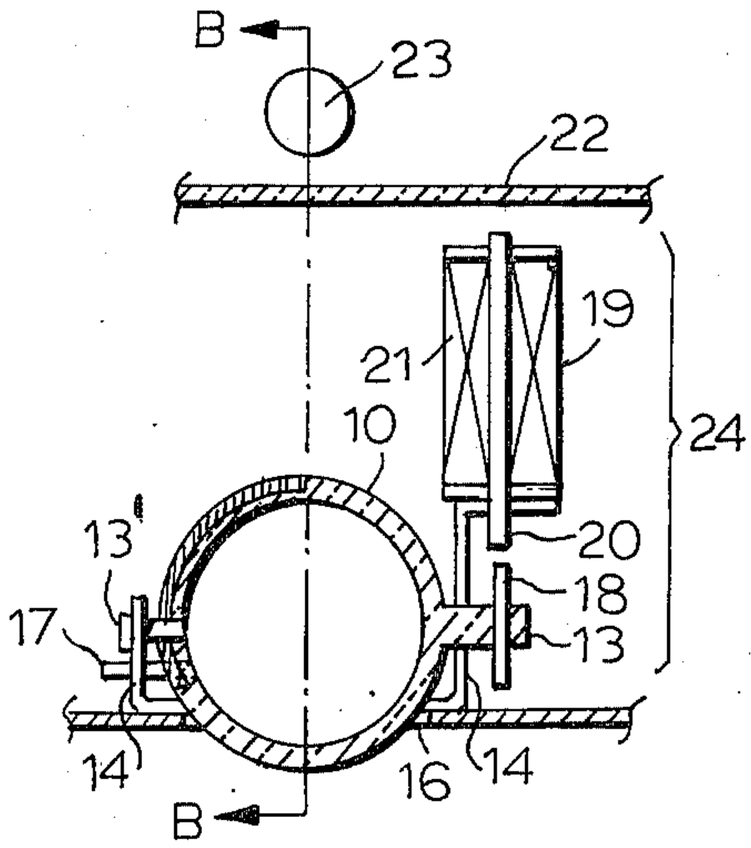


FIG.4

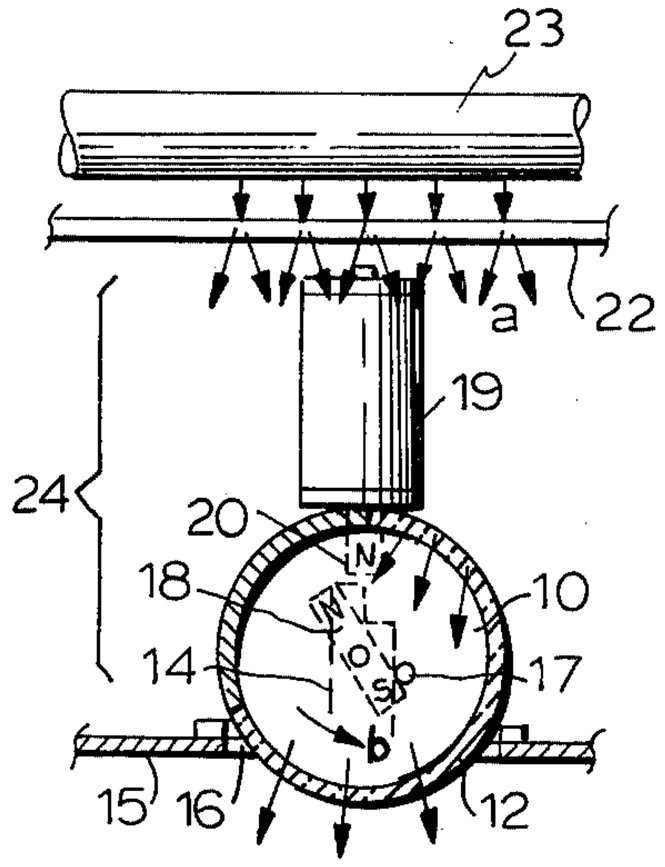


FIG.5

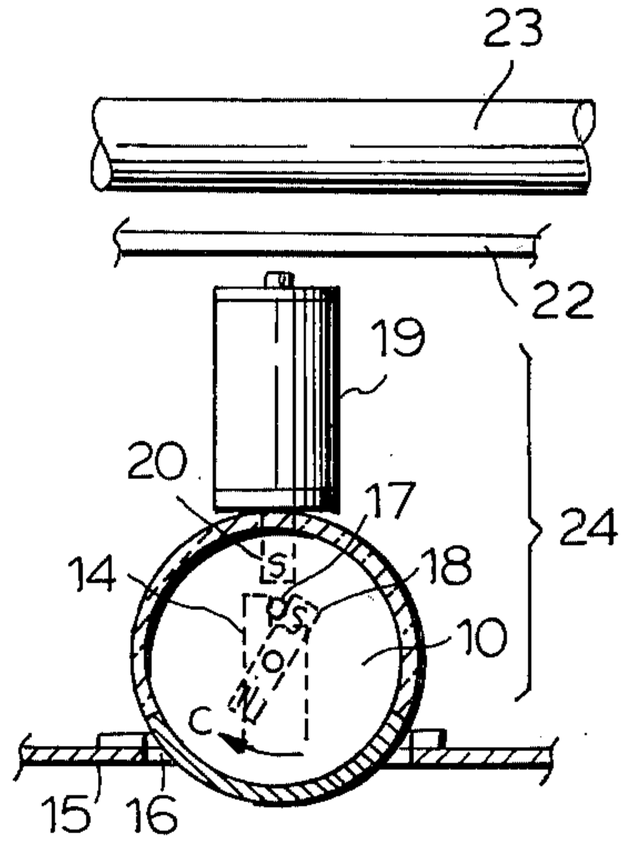


FIG.6

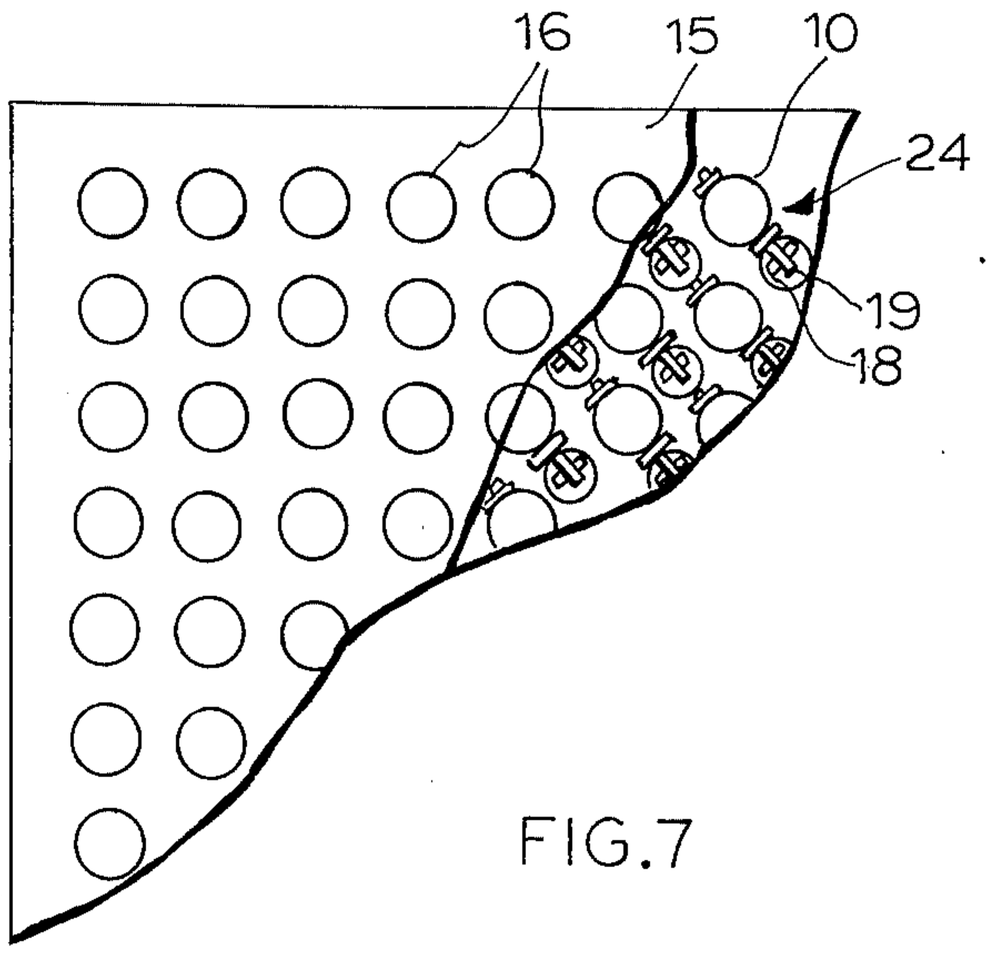


FIG.7

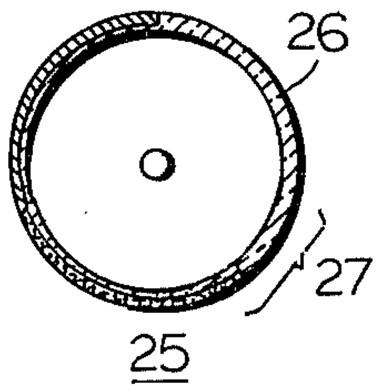


FIG 8

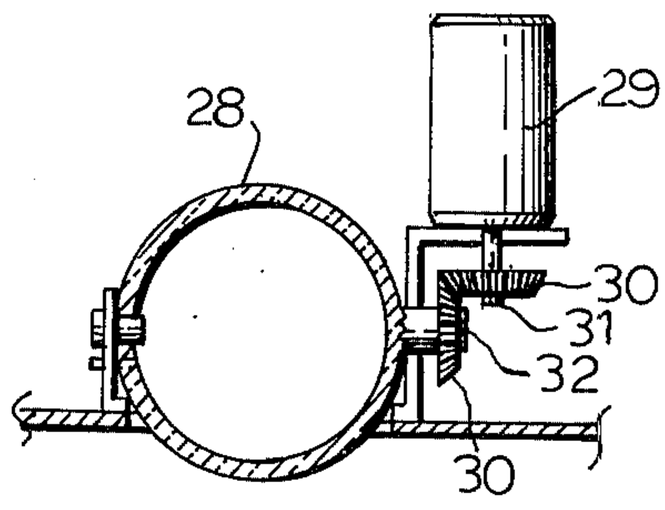


FIG 9

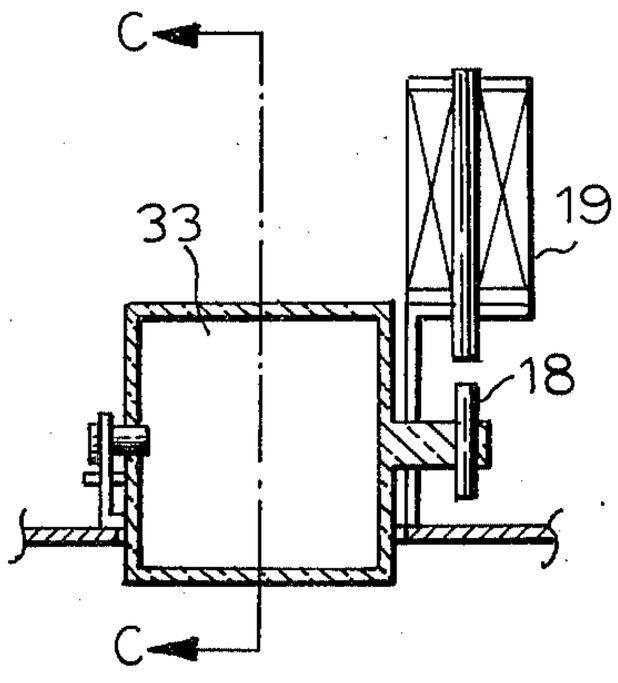


FIG.10

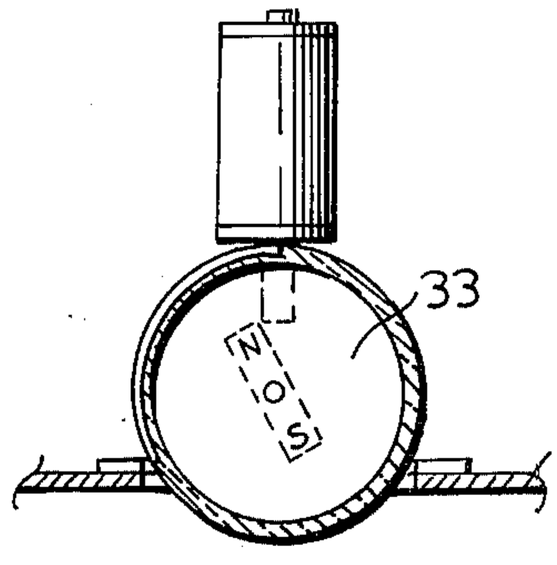


FIG.11

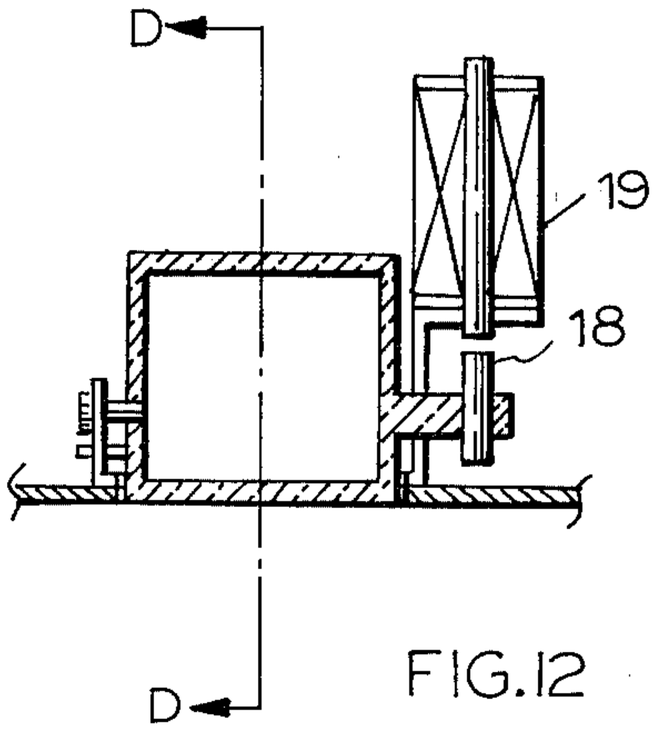


FIG.12

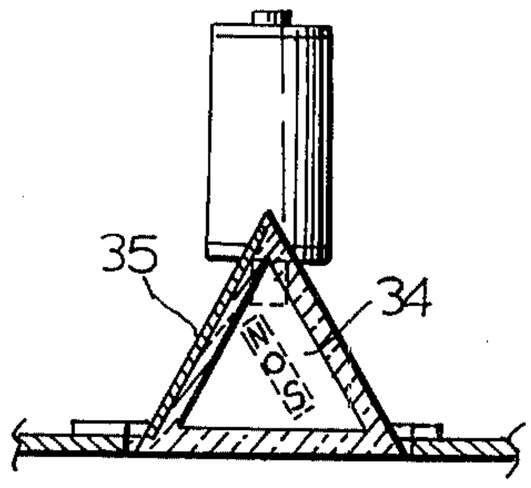


FIG.13

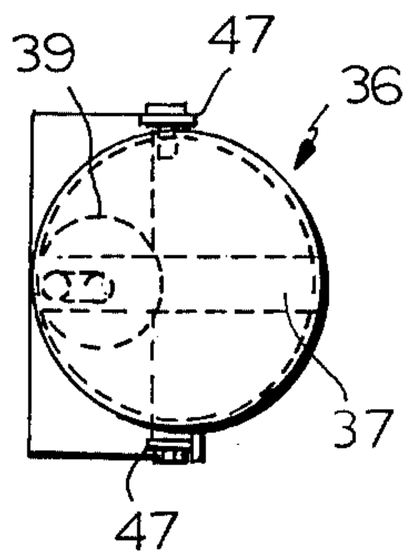


FIG.16

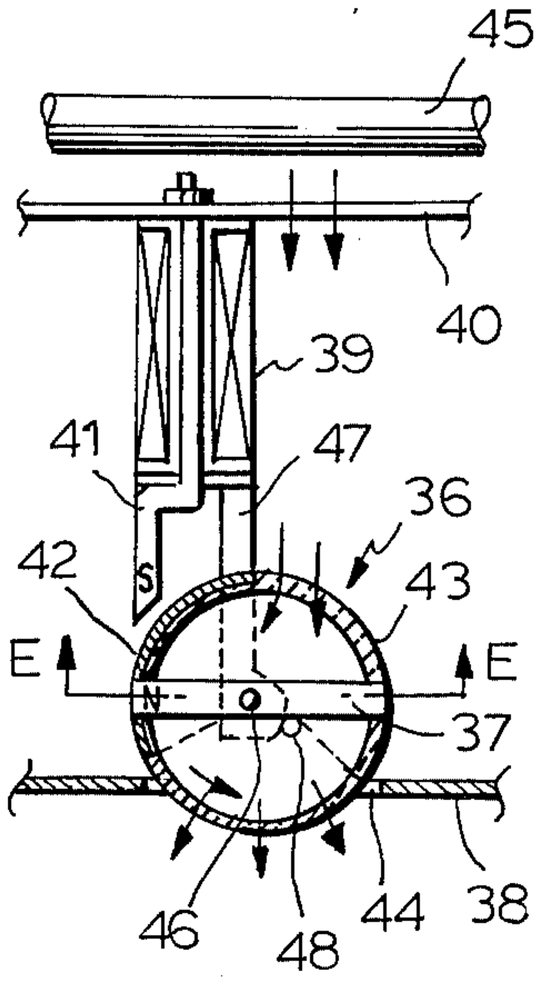


FIG.14

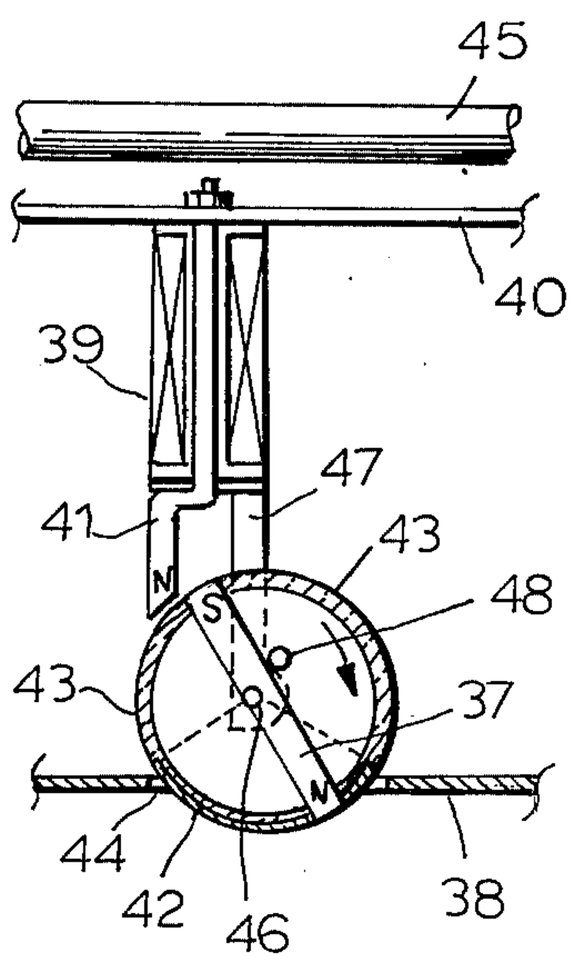


FIG.15

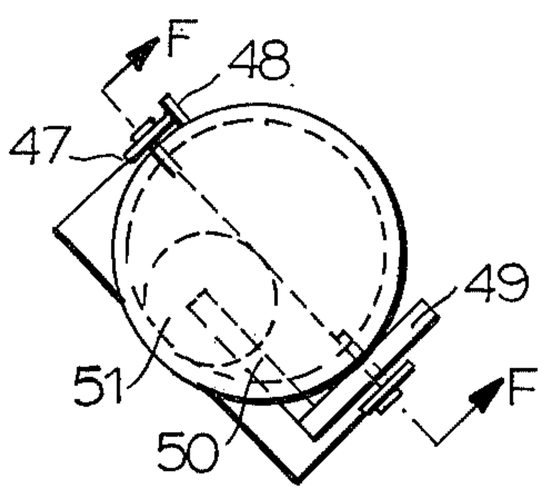


FIG.17a

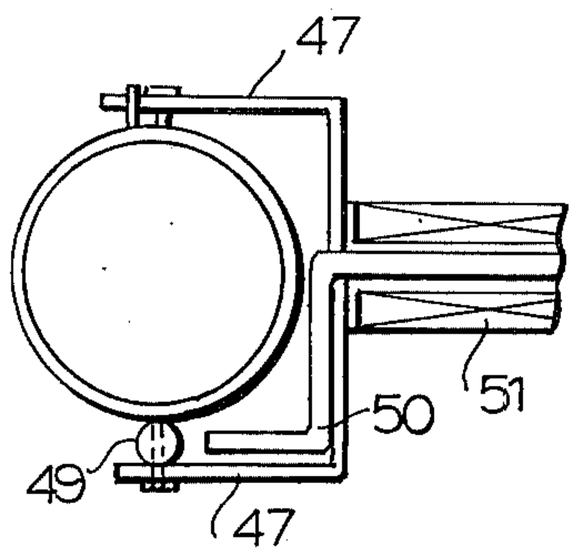


FIG.17b

FIG.18

FIG.19

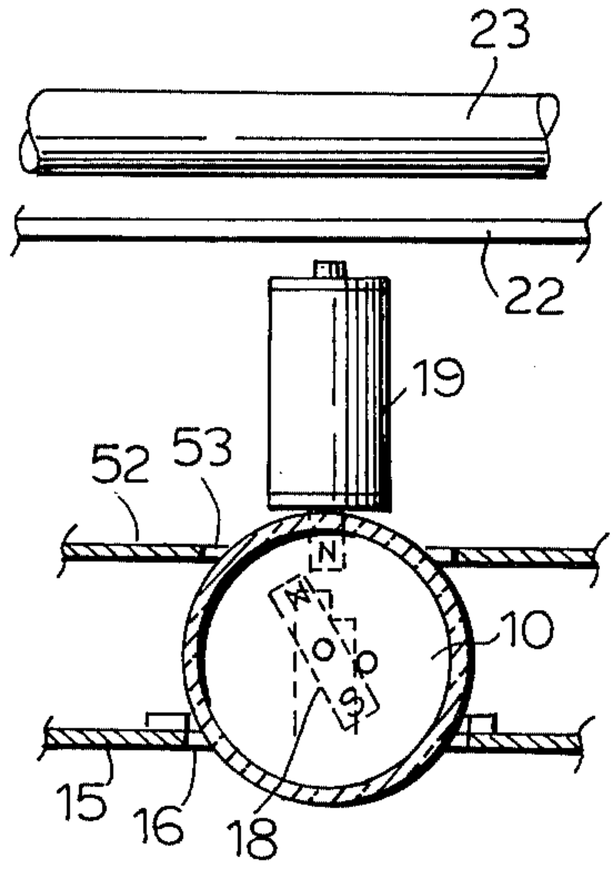


FIG.20

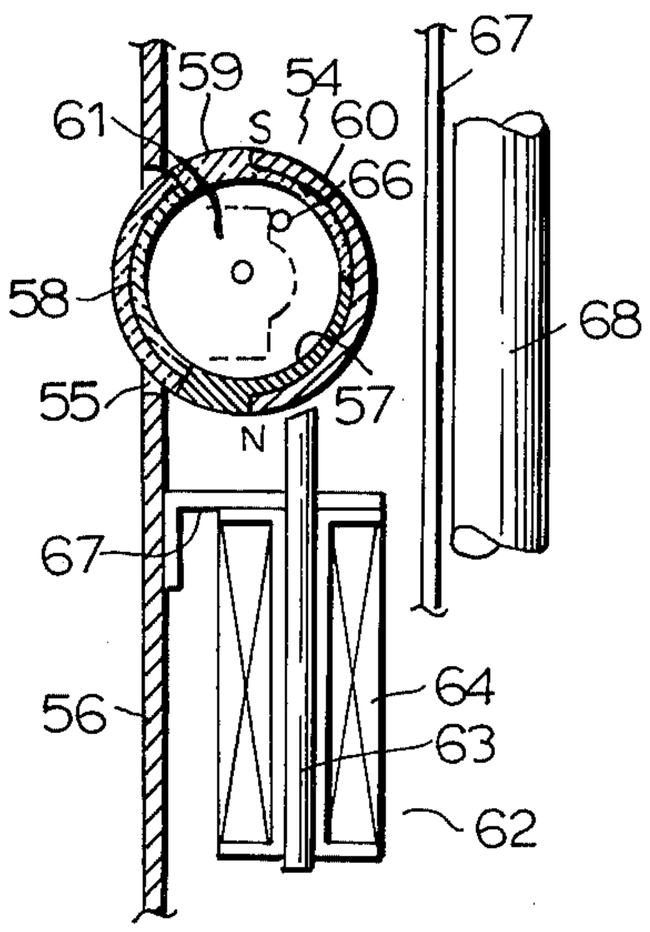


FIG.21

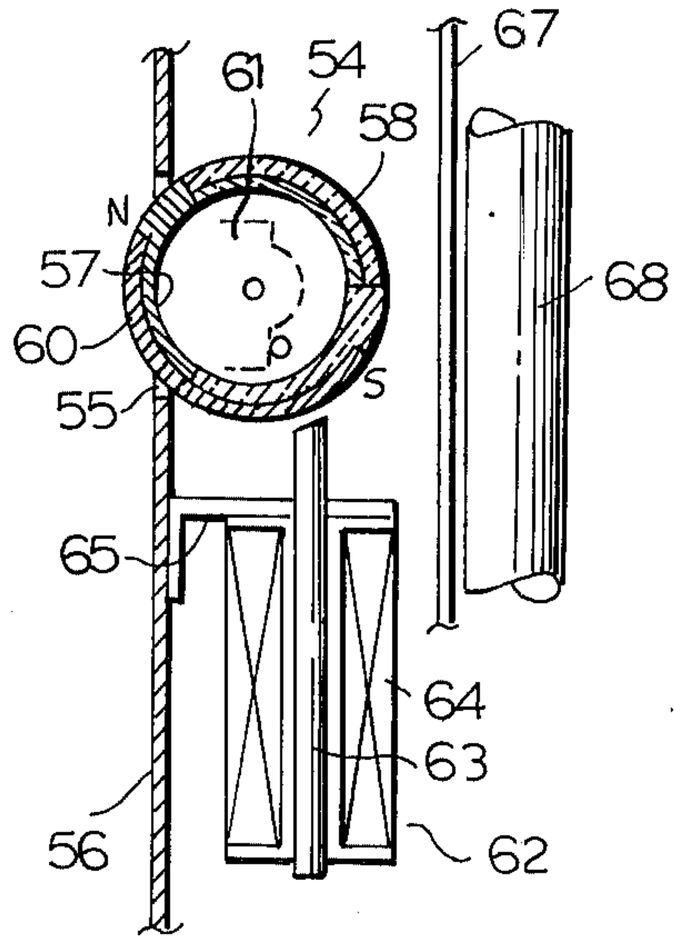


FIG.22

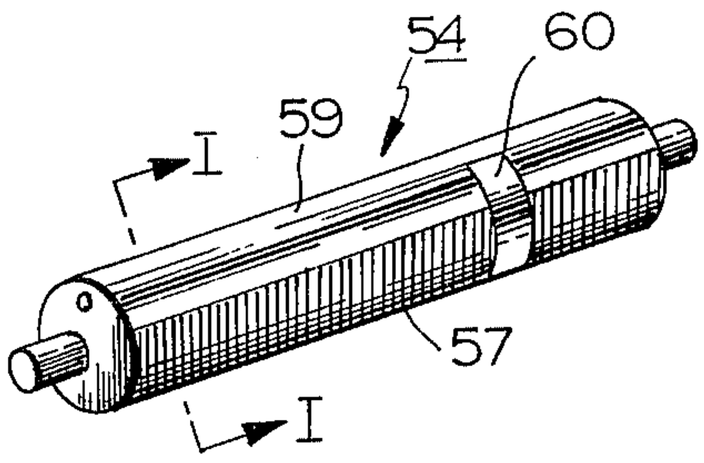


FIG. 23

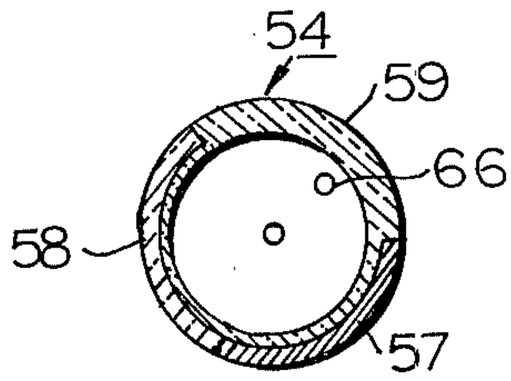


FIG. 24

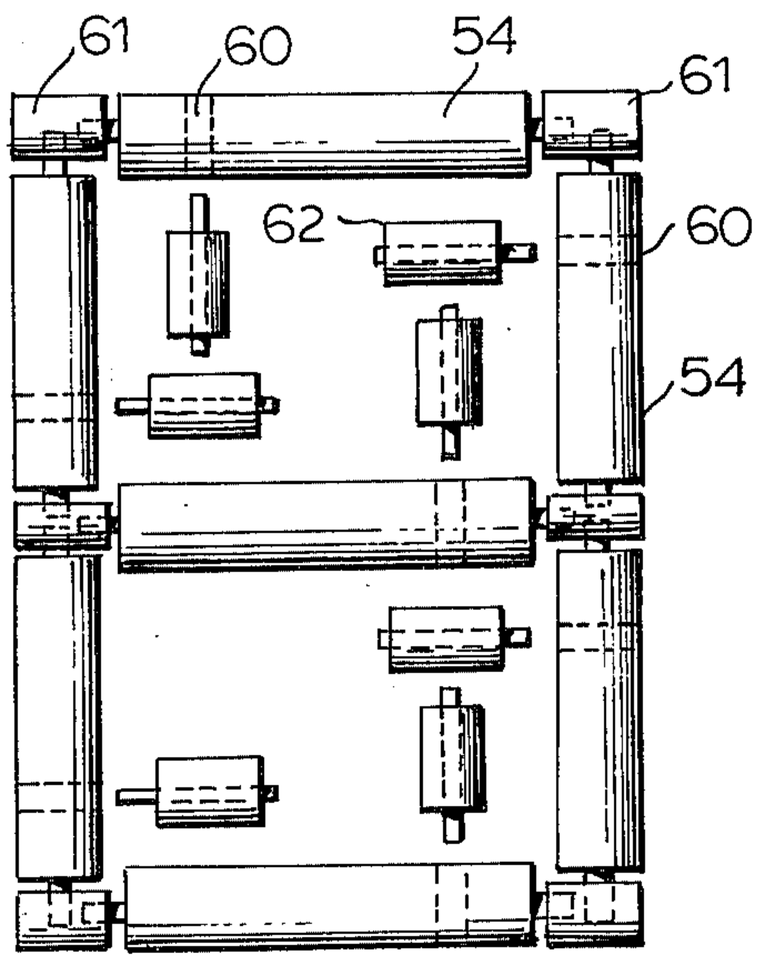


FIG. 25

DISPLAY DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a display device having a display element capable of assuming visually different states, and a plurality of which can be arranged to display a letter, a numeral etc., by selectively positioning each of the display elements in one of above-mentioned different states selectively, and more particularly pertains to such a device in which the display element has visually-different surface portions and is rotated to display one of such portions.

2. Description of the Prior Art

Hitherto known display devices for displaying a numeral, a letter, etc., for a large digital clock, score indications at gymnasia, road information indications, etc., are known.

One example of such a prior art device is as shown in FIGS. **1** and **2.** In this figure, numeral **1** represents an axis and a display element **2** in the form of a spherical body is rotatably supported on the axis **1** in the plane of a panel **8.** The surface of the display element **2** has a black colored portion **3** and a yellow colored (containing a luminous paint) portion **4,** each portion extending over about **180°** of the circumferential surface of the body **2.** A permanent magnet **5** is provided within the display element **2.** Adjacent to the display element **2** is an electromagnet **6** with one end of its core **7** facing the permanent magnet **5.** By selectively polarizing the electromagnet **6,** the desired surface i.e. either the black colored portion **3** or the yellow colored portion **4** can be displayed by creating a repelling or attracting force between the electromagnet **6** and the permanent magnet **5.** By arranging a plurality of such units in a matrix, as shown in FIG. **2,** and displaying the yellow colored portion **3** of suitable units a desired numeral or letter can be displayed. In the daytime, contrast of the display with the panel is obtained by reflection of sunlight, but at night the display elements **2** are irradiated with ultraviolet rays from a black light, so that luminous paint coated on the yellow colored portion **4** emits luminescence to give contrast to the display.

The display by such luminescence, however, lacks clearness. In practice sufficient doses of black light are not delivered from the black light to the display elements when the arrangement is located far from the black light, resulting in extremely poor brightness. Therefore brightness is not uniform over the whole area of the arrangement so that visibility is not good.

Furthermore the luminous paint deteriorates with the passage of time, decreasing brightness. Especially in use outdoors the deterioration is so severe that the service life of the display element **2** is short.

Further because the luminous paints are available only in a small number of color types, the display color is limited.

Another example of a prior art display device is one in which a plurality of electric bulbs or fluorescent lamps are arranged in a matrix or in a figure "⊟", and the display of a numeral or a letter is made by turning on the electric bulbs or the fluorescent lamps at specified positions.

Such a display device, however, has drawbacks as follows:

1. It is hard to be seen when exposed to direct sunlight.

2. Since the electric bulbs or the fluorescent lamps need to be always energized when the indication is continuously made, the amount of power consumed is large.

3. Since many bulbs or fluorescent lamps are used, maintenance of the device including their replacement because of breakage is costly.

SUMMARY OF THE INVENTION

The first object of this invention is to provide a display device which can display a numeral, a letter, etc. clearly both in the daytime and at night.

The second object of this invention is to provide a display device in which the composition of the device for night displaying is improved so that maintenance because of deterioration or breakage is easy.

These objects are achieved by this invention, wherein a display element is made partly transparent in such manner that the transparent portion can be positioned partially inside and partially outside the panel of the device at the same time and light can be irradiated on the display element from inside of the device, so that when the transparent portion is displayed the light from inside will be scattered through the display element.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantageous features of this invention will be apparent from the following explanation taken in connection with some embodiments thereof shown in the accompanying drawings, in which:

FIG. **1** is a sectional view, on an enlarged scale, of one element of a conventional display device;

FIG. **2** is a plan view of a conventional display device using the elements of FIG. **1;**

FIG. **3** is an elevational view of one embodiment of a display device according to this invention;

FIG. **4** is a sectional view taken on line A—A of FIG. **3;**

FIGS. **5** and **6** are sectional views taken on line B—B of FIG. **4** for explaining the operation of the display device of FIG. **3;**

FIG. **7** is a partial plan view showing an arrangement of the elements shown in FIG. **3** in a display panel;

FIG. **8** is a transverse sectional view of a display element according to another embodiment of this invention;

FIG. **9** is a transverse sectional view of still another embodiment of a display device according to this invention;

FIG. **10** is a sectional view of still another embodiment of a display device according to this invention;

FIG. **11** is a sectional view taken along line C—C of FIG. **10;**

FIG. **12** is a sectional view of still another embodiment of a display device according to this invention;

FIG. **13** is a sectional view taken on line D—D of FIG. **12;**

FIGS. **14** and **15** are sectional views of still another embodiment of a display device according to this invention;

FIG. **16** is a sectional view taken on line E—E of FIG. **14;**

FIG. **17***a* is a plan view of still another embodiment of a display device according to this invention;

FIG. **17***b* is a sectional view taken on line F—F of FIG. **17***a;*

FIG. **18** is a elevational view of still another embodiment of a display device according to this invention;

FIG. **19** is a sectional view taken on line G—G of FIG. **18;**

FIG. **20** is a sectional view taken on line H—H of FIG. **19;**

FIGS. **21** and **22** are sectional views of still another embodiment of a display device according to this invention;

FIG. **23** is a perspective view of a display element in the display device of FIG. **21;**

FIG. **24** is a sectional view taken on line I—I of FIG. **23;** and

FIG. **25** is a plan view showing an arrangement of the display devices shown in FIG. **21.**

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. **3** –**6** which show the first embodiment of this invention, a hollow ball shape display element **10** has spherical lune **11** of the outer circumferential surface thereof contained in an angle of about 120° nontransparent (e.g., coated black), and the remaining part **12** transparent (e.g., made of highly transparent, yellow acrylic resin). An axle **13** integral with the display element **10** on one side thereof is rotatably supported by one upstanding portion of supporting plate **14** and a supporting pin **13** is securely mounted on the other side of the display element and is rotatably mounted in the other upstanding portion of plate **14** for supporting the display element **10.** A panel **15** coated black, the same color as the nontransparent part **11** of the display element **10,** has a hole **16** therein through which a portion of display element **18** projects and in which the display element **10** is rotatable. The supporting plate **14** is securely mounted on the panel **15,** and has a hole aligned with the hole **16** in the panel **15.** A stop pin **17** is securely mounted on the display element **10,** which limits the rotation of the display element **10** by abutting the supporting plate **14.** A permanent magnet **18** is securely mounted on the axle **13** and an electromagnet **19** is mounted on an extension on the supporting plate **14,** which electromagnet is composed of an iron core **20** facing the end of the permanent magnet **18** with a gap therebetween and a coil **21.** A light diffusing plate **22** is provided for the purpose of uniformly diffusing on the display element **10** the light radiated from a light source **23** such as a fluorescent lamp. Plate **22** may be formed of a milky white acrylic resin, for example.

The operation of the embodiment constructed as described above is as follows: FIG. **5** shows the condition of this device in which a display is formed with the yellow transparent part **12.** During the daytime, the display element **10** forms the display by the reflection from the transparent part **12,** which is clearly visible even when exposed to the sun's rays. At night, the light source **23** is turned on. Then, the light produced from the light source **23** is uniformly diffused through the light diffusing plate **22,** and passes through the plate **22** as indicated by the arrow a, reaching the display element **10.** Since the right half of the display element **10** is composed of the yellow transparent part **12,** the light passes through the right half of the display element **10,** and is scattered throughout the display element **10** while being transmitted therethrough. It, then, comes out through the yellow transparent part **12** projecting through the panel **15.** Thus, the display element **10** produces a very clear display, giving a shining appearance like an electric bulb. Although the left half of the display element **10** is composed of the black nontransparent part **11,** the light is scattered throughout the display element **10** with the right half being of the transparent material, not allowing the left half with the black nontransparent part **11** to cast a shadow. Accordingly, the yellow transparent part **12** which is visible through the hole **16** of the panel **15** shows no irregularity in the emitted light, giving a uniformly shining overall appearance to the display element **10.** Furthermore, if the light source **23** or the light diffusing plate **22** is colored differently from the transparent part **12** of the display element **10,** e.g., red, then the display may be made yellow in the daytime, while a mixed color of yellow and red, i.e., orange, may be produced at night. If a sodium lamp is used for the light source **23,** high visibility is obtained even in the rain or mist.

Then, when the coil **21** is energized so as to produce a N pole at the tip of the iron core **20,** as shown in FIG. **5,** it repels the N pole of the permanent magnet **18,** while attracting the S pole, causing the display element **10** to turn in the direction shown by the arrow *b*. When the display element **10** has made a 120° turn, the stop pin **17** abuts the supporting plate **14,** as shown in FIG. **6,** bringing its rotation to a stop. In this condition, the black nontransparent part **11** faces the hole **16,** as shown in FIG. **6,** and even if the light source **23** is turned on at night, the light will not leak out through the panel **15,** being shielded by the black nontransparent part **11.**

If the condition of FIG. **5** is needed again, the coil **21** is so energized as to produce the S pole at the tip of the iron core **20,** as shown in FIG. **6.** It repels the S pole of the permanent magnet **18,** while attracting the N pole, causing the display element **10** to turn in the direction shown by the arrow *c*. When the display element **10** has made a 120° turn, the stop pin **17** abuts the supporting plate **14,** as shown in FIG. **5,** bringing its rotation to a stop. Thus, the display is made by means of the yellow transparent part **12.**

In such device, the coil **21** need be energized only for the short period of time necessary to alter the substance of the display (the time taken for the display element **10** to turn to expose the different part through the hole **16);** thereafter a self-maintaining magnetic force is produced through the attraction between the permanent magnet **20** and the electromagnet **19,** thereby making it possible to hold the condition of the display unaltered. There is, for this reason, no need for energizing the coil **21** unless the display is to be altered, resulting in very small consumption of power and economy of operation.

A plural number of such display units **24** are arranged in the configuration of a matrix, as shown in FIG. **7;** the electromagnet **19** and the permanent magnet **18** of every display unit **24** are installed at a position where they are not visible through the holes **16** in the panel **15,** that is, located in the space surrounded by four display elements **10,** as shown in FIG. **7,** and a plurality of light sources is provided. With this arrangement, there is no physical body which will obstruct the light coming from the light source inside or at the rear of the display element **10.** For this reason, either in the daytime or at night, all the display elements have a uniformly shining appearance, thereby giving very clear indications.

While in the embodiment described in the foregoing, the display element **10** is a hollow ball, it is also possible to obtain a similar effect by making the whole of the display element a yellow transparent acrylic resin, without making it hollow. In such an embodiment, only the part of the display element in the 120° lune is coated with the black nontransparent color. This range is not

limited to 120°, however, and any angle which is smaller than 180° but large enough to block the hole in the panel **15** will do in providing a similar effect. Furthermore, in the display element **25,** as shown in FIG. **8,** the inner transparent part **26** contained in the 120° lune on the inside of the transparent part **27** may be made with a transparent material, or may be notched, or some undulations may be provided on its surface to ensure better diffusion of light.

FIG. **9** shows another embodiment of the driving means for the display element **28,** illustrating the use of a motor **29.** Bevel gears **30** are respectively mounted on the shaft **31** of the motor **29** and the axle **32** of the display element **28.**

In operating this device, the display element **28** is turned through the bevel gears **30,** with the polarity of the current for energizing the motor **29** being changed.

FIGS. **10–11** show a display element **33** having a cylindrical shape, with only the part of the outer circumference contained in a center angle of 120° as the black nontransparent part.

The display element **34** of FIGS. **12–13** is a triangular prism, the triangular display element having one side as the black nontransparent part **35.**

FIGS. **14–16** show another structure for installing the driving means and the display element of this invention.

Inside the display element **36,** a permanent magnet **37** is diametrically disposed, extending at both ends to the outer circumference of the element **26** with its axis crossing the rotational axis **46** which is supported parallel to the panel **38** by a supporting plate **47.** The magnet is brought parallel to the panel **38** when the transparent part **43** is in the hole **44** of the panel **38.**

The electromagnet **39** is mounted on the light diffusing plate **40** with a tip part of the core **41** thereof turned toward the display element **36** and opposite the nontransparent part **42** which is located inwards of the panel **38** when the transparent part **43** of the display element **36** is in the hole **44** of the panel **38,** that is, in the displaying position, as shown in FIG. **14.** With this arrangement, even when the light source **45** is turned on at night, the electromagnet **39** does not cast its shadow on the transparent part **43.** The permanent magnet **37** not only has a small diameter, but is held parallel to the panel **38** at a proper distance from the transparent part **43** in the hole **44.** Accordingly, its shadow does not reach the hole **44.** The transparent part **43** in the hole **44,** then, shines very clearly with no irregularity of the light. The rotated position of the display element **36** is set by the cooperation of the supporting plate **47** and a pin **48** on the display element **36.** According to this embodiment, the distance between neighboring display elements **36** can be small. If the diameter of the display element **36** is very small, however, there is a danger of the permanent magnet **37** installed inside the display element **36** casting its shadow on the transparent part **43** in the hole **49** at night. For this reason, it is preferable to mount the permanent magnet on the end of the rotational axle **46** outside of the display element **36,** as shown in FIGS. **17***a* and **17***b*. Referring to FIGS. **17***a* and **17***b* numeral **49** represents the permanent magnet and **50** the core of an electromagnet **51.**

FIGS. **18–20** illustrate a structure which is effective, for eliminating the leakage of light through the clearance between the hole **16** in the front panel **15** and the display element **10** when the light source **23** is turned on at night. This structure is the same as the embodiment of FIGS. **3–6** and to which is added to a rear panel **52.** Aligned with the hole **16** in the front panel **15** is a hole **53** in the rear panel **52** provided at the rear of the display element **10** and having a size somewhat smaller than the display element **10.** With this set-up, the light source **23** can not be directly seen through the hole **16** in the front panel **15.** Thus, the leakage of light through the clearance between the hole **16** and the display element **10** is eliminated, thereby making the display very clear.

The operation of this embodiment is the same as that of FIGS. **3–6.**

In mounting the permanent magnet on the rotary display element to serve as the driving means for this rotary display element, it is preferable to securely mount it inside the rotary display element for making the overall size of the device small. However, the permanent magnet must not block any of the light from the light source passing through the rotary display element. The following embodiment has a structure satisfying such requirements particularly for segments for numeral display.

Referring to FIG. **21–24,** there is provided a cylindrical transparent rotary display element **54** having a diameter somewhat larger than the lateral width of the opening **55** in a panel **56,** which cylinder is placed in the opening **55.** The outer circumference thereof is divided into nearly equal three parts, a nontransparent display part **57,** a transparent display part **58** and a transparent part **59,** having the boundary running parallel to the rotational axis, as shown in FIGS. **23** and **24** (the transparent part **59** may be replaced by an enlarged transparent display part **58).** The nontransparent display part **57** is black, the same color as that of the panel **56,** for prevention of transmission of light, and the transparent display part **58** is coated with a highly transparent yellow acrylic resin, for example. A semi-circular permanent magnet **60** is embedded in the outer circumference of the rotary display element **53** on the opposite side from the transparent display part **58** and extends in the circumferential direction, straddling the nontransparent display part **57** and the transparent part **59.** Bearings **61** support both ends of this rotary display element **54,** and an electromagnet **62** aligned with magnet **60** rotationally drives the rotary display element **54** in cooperation with the aforementioned permanent magnet **60.** The electromagnet **62** is composed of an iron core **63** and a coil **64,** a shown in FIGS. **21** and **22,** and is supported by the mounting plate **65** mounted on the panel **56** in the neighborhood of the rotary display element **54.**

A stopper pin **66** is provided on one side of the rotary display element **54,** which is adapted to limit the turning of the rotary display element **54** by abutting the end of the bearing **61.** Behind the rotary display element **54** are a light diffusing plate **67** and a light source **68** with which the rotary display element **54** is irradiated, to project the light to the outside of the opening **55** through the transparent display part **58** when it is in the opening **55** side of the panel **56,** as shown in FIG. **21,** thereby providing the indication. It is appropriate to coat the inside surface of the aforementioned nontransparent display part **57** to ensure good reflection of light.

The operation of this display device is the same as the device of FIGS. **5–6.** A plurality of display units can be arranged as numeral segments in the manner as shown in FIG. **25.**

In the embodiment above described, one-third of the outer circumference of the rotary element **54** is the transparent part **59,** but this transparent part **59** may be

eliminated by forming the two-third of the outer circumference as a transparent display part **58.** Furthermore, it is not objectionable for the light from the light source **68** to be irradiated on the transparent display part **58** placed in the hole **55** to enlarge the nontransparent display part **57** to larger than one-third but smaller than one-half of the outer circumference of the rotary display element **54** in order to provide proper shielding of the hole **55** in the panel **56.** The structure of the embodiment above described, may be applied to devices in which spherical rotation elements are used.

What is claimed is:

1. In a display device of the type having a display element with a surface including different colored areas, which display element is rotatably mounted opposite an opening of a front panel, and including means for controlling the rotational position of said display element to selectively expose a specified colored area through the opening of the front panel, the movement comprising:

the surface portion of said display element having a non-transparent area, a transparent area having a color different from the color of said non-transparent area, and a light passing portion which is positioned inside the front panel when said transparent area is exposed through the opening of the front panel, said light passing portion being optically connected to said transparent area and said non-transparent area having a size for completely covering said opening in the front panel when said non-transparent area is exposed to said opening; and

a light source positioned behind said display element, whereby the light from the light source is scattered to the otuside of the front panel through the display element when the transparent area is exposed through the opening.

2. The improvement as claimed in claim **1** in which said transparent area extends around said element to form said light passing portion.

3. The improvement as claimed in claim **1** in which said display element is a hollow body having an opening in the wall thereof constituting said light passing portion.

4. The improvement as claimed in claim **1** in which said means for controlling the rotational position of said display element comprises a permanent magnet securely attached to the display element and an electromagent mounted adjacent said display element.

5. The improvement as claimed in claim **1** further comprising a light diffusing plate between said light source and said display element.

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